Measures and regulation to increase the demand flexibility and controllability for systems with large shares of variable RES-E

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RESPOND Session

Measures and regulation to increase the **demand flexibility & controllability for systems with large** shares of variable RES-E

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RESPOND
Renewable Electricity Supply interactions with conventional POwer generation, Networks and Demand

Demand response

Demand response is to get customers to react to variations in the cost of production:

- Increase demand when costs are low
- Decrease demand when costs are high

Increased intermittent production e.g. wind implies an increased variation in **production** and in the **marginal costs** of production.

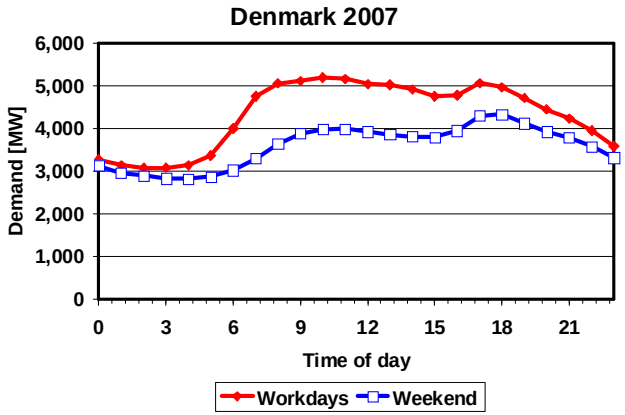
Marginal costs of production are revealed through the market price. That is, customers should react on market prices.

Time of notice/reaction is very important:

- Within seconds to 15 min. response should be automatic or centrally controlled.
- With a reaction time of 1 hour to day ahead, prices may play a role.

In this presentation focus is on economic incentives and day ahead hourly market prices.

A general description of the hourly electricity market:



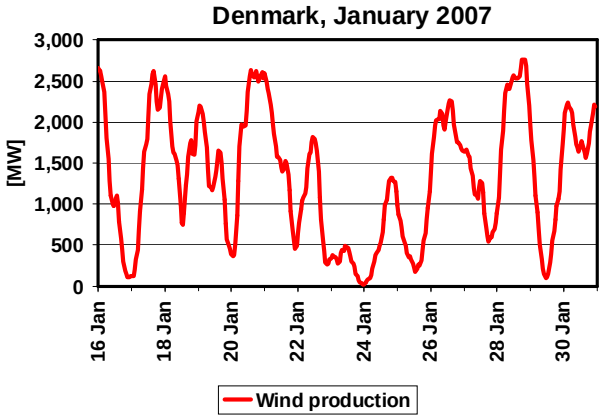
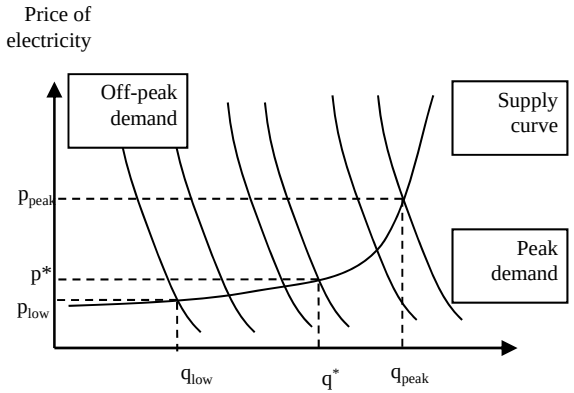
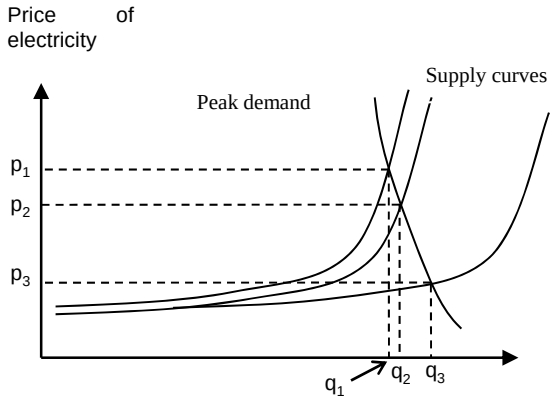


Figure 1. Average hourly consumption curve for Denmark 2007, and variation of the wind power production in second half of January 2007 for West Denmark

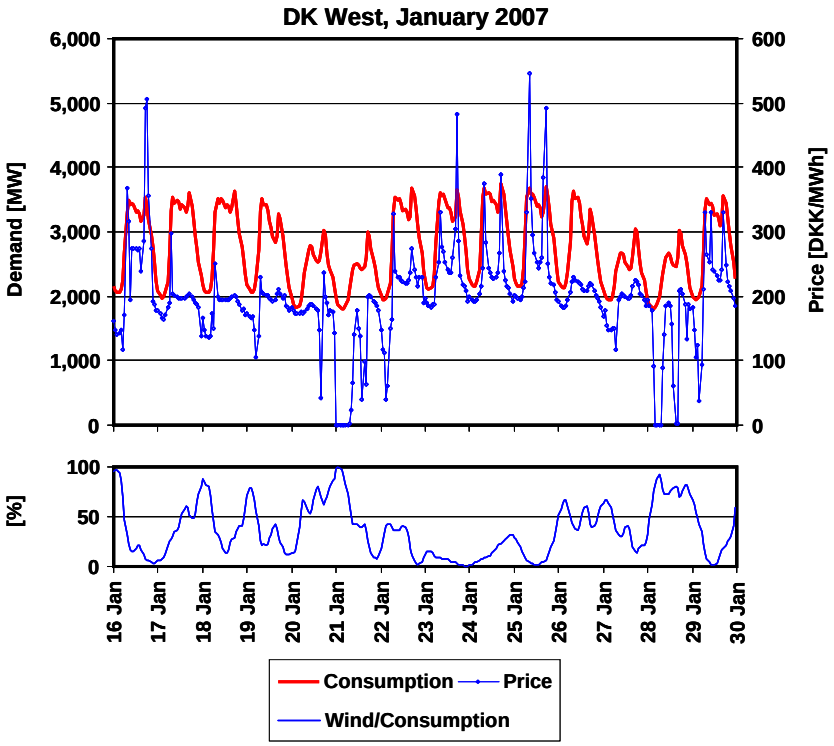




Demand:
Systematic daily variation, shifts the demand curve, positive correlation between price and quantity.

Supply:
Unsystematic variation in the supply of wind, shifts the supply curve, negative correlation between price and quantity.

Figure 2. Effects of changes in the demand and supply of electricity.



Hourly Nord Pool prices, consumption, and wind power production in West Denmark, the second half of January 2007.

Combining effects (in a system with considerable wind and at the border of thermal and water-based production) and looking at hourly prices, consumption and the share of wind.

Observations:
- a systematic daily and weekly variation in demand and the price of electricity
- unsystematic peak prices often related to limited wind power
- unsystematic low or even zero prices often related to a large production from wind

Concerning **intermittent production** the main observation is the **unsystematic variation** in production and prices.

Conclusion: To increase the share of intermittent production we would like customers to react to unsystematic variations in production and prices.

Requirements to get customers to react on varying prices:

- **metering** at the relevant level of time-intervals
- **pricing/billing** according to varying costs of producing electricity or other incentives for changing consumption
- **technical possibilities** for customers to change consumption

Metering of consumption:

Today many customers have **quarterly/annual metering** of consumption and face an average price.

However, **programmes for changing meters** exist in several countries.

Italy, Spain:	A general roll-out of interval meters to all customers has started.
Netherlands:	A general roll-out was decided but is suspended due to discussions on functionality of meters.
UK, Denmark:	Large customers have interval meters, a general roll-out to small customers not decided, but some small customers get interval meters
Germany:	Individual customers may choose to install an interval meter.
Barriers:	**Functionality** of meters, communication **standards**, **costs** of meter and metering, **ownership** of meters.

Recommendations:	**General roll-out should be encouraged**, at least to all customers in specific areas. A first step is to define the functionality and communication standards. (simple/smart meters). **Meters should be prepared for being smart**. **Ownership of meters**: In **UK** typically the supplier of electricity. Compensation if customers change supplier. In **DK** DSOs own the meter and distribute measurements to relevant supplier, who pays for this service.

Pricing rules

Theory: Customers should be charged the marginal costs of generation, e.g. day ahead market prices.

Status in countries: Most customers does not see day ahead prices. In UK and Denmark large customers may choose a tariff reflecting day ahead market prices (most customers choose a fixed tariff). In Spain TOU tariffs are used intensively and in the Netherlands a simple peak/off-peak tariff is available.

Barriers: a) information cost and cost of changing consumption b) transfers between customers c) short-term gains small, long-term gains are larger but not very transparent for the customers.

Recommendations:
a) Information costs will always reduce the incentive for changing consumption, but **information costs may be reduced** by future technologies. Define a communication standard for information on prices.
b) Fixed rates imply cross-subsidies between customers. Using hourly prices, customers with a large consumption in expensive hours have to pay more. This is wanted and implies that **customers should not be given the opportunity to choose anything but hourly market prices**.
c) Small short-term gains are partly due to fixed additives to market prices. **Fixed additives should be reduced**, possibly changed to % on market prices.
In the future short-term gains may increase due to increased intermittent production and volatility of prices.

Incentive based programs

Theory: As the time of reaction becomes very short, price-signals become inefficient and incentive based programs with pre-determined actions or centrally controlled actions become more efficient. Payment is a reservation payment or a discount on the price of electricity.

Status in countries: Spain 211 large customers have signed interruptible contracts. In DK a few large customers have signed interruptible contracts in a demonstration project. A few large customers participate in the market for reserve capacity. In the Netherlands large industrial and horticultural customers participate in the market for reserve capacity.

Barriers: a) Identify customers/consumptions that may be cut-off with short notice. b) Aggregation rules for participating in reserve market. c) Develop mass market initiatives (small customers).

Recommendations:
Identify consumption that may be cut of at little inconvenience and develop rules for aggregation of medium-sized customers so that they may bid into the market for regulation.
Develop standards for small customer contracts and communication standard related to centrally controlled cut-off of consumption.
Introduce frequency controlled cut-off technology in new household appliances where short-term cut-offs have minor implications for the customer e.g. water heaters, refrigerators.

Technical possibilities I

Enabling technologies e.g. smart meters and control of consumption are at present mainly developed for increasing comfort and saving energy, but many of the same technologies may be **used for demand flexibility.**

Technologies using price signals: A chip that react on price signals may be introduced in quite a lot of appliances, mainly related to heating and cooling. US Electric Power Research Institute has a study that suggest some reluctance to have unknown controls installed in their equipment, but if the appliance comes with a control chip out of the box, the barrier will be overcome.

Recommendations: **Develop** communication and **control units** that react on a price – or another signal.
Give **incentives for** a market where **new appliances** have a control unit.

Frequency controlled cut-off: A chip that reacts on changes in the net-frequency is installed in individual appliances, mainly related to heating and cooling appliances that may be cut-off for a shorter period.

Recommendations: For relevant appliances, make a choice between price- and frequency controlled cut-off, and require that relevant new appliances are born with frequency controlled cut-off.

Technical possibilities II

Electric vehicles: Very large potential, in the short term charging from the net when excess capacity is available, and should in the long term be able to supply electricity to the grid in congestions

Recommendations: Make sure that electric vehicles are **charged when it is convenient for the system**, either through prices or centrally controlled charging.
In the long-term develop systems where the **battery** acts **as a storage** for the system.

Electric storage: Quite large number of possibilities, Hydrogen, batteries, pump-storage etc. At present quite expensive technologies. Used batteries from electric vehicles is an option.

Recommendations: **Research and demonstration projects** for the different competing storage technologies. At present most storage technologies need to become cheaper, more efficient and a long-term winner is difficult to pick.

Summary and conclusions

- Metering: Hourly metering required in order to prepare for price-flexible consumption.
  General roll-out cheaper that individual decisions.
  Communication standards and functionality need clarification.
- Prices: Default, customers should face hourly market prices.
  Fixed price-additives should be reduced to increase incentives.
  (gains small at present, but will increase with increased wind)
  Cost of obtaining price-information should be decreased.
  (automatic display of prices)
- Short time of notice: Many small customers, aggregation rules and standard contracts for centrally controlled cut-off.
  Frequency controlled cut-off technology in new appliances.
- Technologies: Electric vehicles; make sure that batteries are charged according to needs of the system.
  Storage of electricity at present expensive